Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

THE

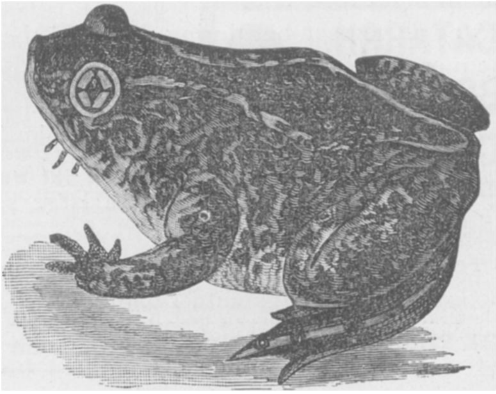
AMERICAN NATURALIST.

VOL. XVIII.—*NOVEMBER*, 1884.—No. 11.

RECENT STUDIES OF THE SPADE-FOOT TOAD.

BY CHARLES C. ABBOTT, M.D.

IN a sink-hole in a dry upland field near Trenton, New Jersey, on April 10, 1884, there suddenly appeared a large colony of hermit spade-foot toads (*Scaphiopus holbrooki*), which, by their remarkable cries, attracted the attention of every one passing by. So unlike the cries of any other of our batrachians were their utterances, that all who heard them were attracted to the spot, and wondered, when they saw the animals, that so great a volume of sound could issue from so small an animal. One need not wonder, however, on this point if they will but examine the development of the animal's vocal cords. The machinery for producing sounds equal to an ordinary steam whistle are apparently contained in the throat of this rare and curious batrachian. Holbrook, in his diagnosis of the genus Scaphiopus, refers to the "sub-gular vocal sac" of the males; but it must not be inferred that the females are voiceless. That they are not so noisy is probable, but occasion requiring, they can readily make themselves heard.



Scaphiopus holbrooki.

These spade-foots remained in the shallow waters of this sink-hole until April 15, when the weather becoming considerably cooler, they as suddenly disappeared as they had come. In May, 1874, these toads appeared in like manner in the same locality, remained but a few days and were gone. In the intervening ten years not a specimen was seen or heard, although careful search, annually, was made. I supposed, when they appeared in April of the present year, that they spawned previous to their sudden disappearance, but neglected to investigate the matter in consequence of a press of work in other lines of investigation. The spade-foot toads were soon forgotten. The wealth of bird-life that came trooping in from the South during May, and their subsequent nesting, occupied my thoughts and were the prominent objects sought during my daily rambles.

It was not long, however, before the spade-foots again became the prominent feature of the fauna of the neighborhood. During the night of June 25–26 a violent north-east storm arose, and rain fell in torrents. The sink-hole, which for weeks had been nearly dry, was again flooded, and on the afternoon of the 26th was literally alive with these rare toads. Sitting upon every projecting stick or tuft of grass, or swimming with their heads above the surface of the water, were spade-foots by the hundred, and every one apparently uttering those shrill, ear-piercing groans that only these batrachians can utter. Not only during the day but all night their cries were kept up. The following day there was no abatement, but during the night the sound decreased. On the morning of the 28th not an individual was to be seen or heard.

During this brief interval these animals spawned, the eggs being attached to blades of grass and slender twigs. These eggs hatched on the 2d of July and a large series were gathered a week later.

To return to the eggs. During the time that intervened from the laying of the eggs until I gathered specimens of the tadpoles, there occurred four moderately heavy showers, so that the water in the sink-hole at no time disappeared, but was much below the level that it reached during the protracted rain-fall of June 26. Very much, therefore, of the spawn that was laid was high and dry for from two to four days before hatching, and I suppose was destroyed.

On the evening of July 9 I found the water in the sink-hole confined to a few very shallow pools of limited area, and in these pools were a few hundreds of Scaphiopus tadpoles. In comparison with the abundance of eggs seen June 26, and of young seen a week later, it is evident that a large portion of the eggs were destroyed and a vast number of very young tadpoles were killed by the soaking away of the water.

I have never known any like disparity between the eggs of frogs or common toads and the young in the tadpole state; and it is at once very evident that if the spade-foot toads habitually or usually deposit their eggs in temporary pools, then we have an obvious reason for the positive rarity of the animal, as apparently it is the rule, rather than the exception, for the egg to be destroyed or the young perish.

The tadpoles gathered July 9, which were then seven days old, were curious creatures. At this time the hind legs were well developed, although small, and did not interfere with the animal's natatorial locomotion. The bodies of these young Scaphiopi were short, stout and oval, and, when viewed in the water, deep velvety black; but when closely examined it was found that the two irregularly parallel yellow dorsal stripes, that are so prominent a feature in the coloration of the adult male, were plainly discernible.

The movements of these tadpoles were not different from that of the young frogs and toads in this stage of their existence. Those that I had in an aquarium moved in companies as though following a leader, and occasionally one would drop out of the ranks, come quickly to the surface, eject a bubble of air, and dive again quickly to the bottom of the tank. Like all tadpoles they had enormous appetites, and when fed with bits of raw meat quickly attached their sucking mouths to the food offered, and did not remove it, I think, while a particle of blood remained in the mass.

A week later, July 16, the majority of these tadpoles had acquired their front legs, and the tail had perceptibly diminished in size, but still was used by them when moving through the water. At this time, however, the movements of the animal are far less active than before or soon after, and for a few days, if exposed to the attacks of any enemies, would suffer far more than at any other period of their lives.

A very curious feature in the growth of these animals is now to be noticed. Of the specimens I had under examination, in an aquarium, about five per cent did not progress beyond the condition in which all were in July 9. These "retarded" tadpoles proved to be voracious cannibals. They seized their more matured companions by their tails and legs, swallowing the member and thus sustaining their own lives at the expense of their fellows. They generally killed their victim in the course of twenty-four hours, and often in less time, and then promptly seized another. So bloodthirsty were these few "retarded" tadpoles that I was compelled to protect the lives of the little hoppers, their brethren, which now, in spite of stumps of tails, sat in frog-like fashion on their haunches, and were in all respects miniatures of the adult spade-foots that in April and June made night hideous with their unearthly cries.

Having tested several specimens, a few days previously, as to their ability to assume the land-life of adult Scaphiopi, by placing them upon damp sand, and finding that they throve fairly well, on the 25th of July I removed the water in the aquarium and put in earth to about an inch in depth, and very carefully smoothed the surface. Upon this the young spade-foots were placed, and in less than one minute many had commenced digging little burrows, into which they disappeared as the excavations deepened. In all respects these burrows were like those made by adult spade-foots, oval in outline, oblique in direction, and generally with a slight angle in the course. In twenty minutes all but two, of forty-four specimens, were below the surface of the earth stratum I had placed in the aquarium.

It now became monotonous in the extreme to watch them. Not a movement occurred that was other than might be expected of adult toads or frogs of any species.

I did not see them eat, but as only living food would now be accepted by them, it was simply because minute insect life did not come within reach; but while yet in the water these young spade-foots found some food, as shown by the examination of the stomachs and intestines of several specimens. Dr. A. C. Stokes kindly made this examination, at my request, and reported as follows: In the stomach of one was found fragments of a fly and of a small moth, and in the intestine a mass of sand grains cemented together by dark brown amorphous matter, with numerous rhizopods (Arcella) and several diatoms. In the stomach of another a species of Thrips, and a few diatoms in the intestine.

These two species had been thirty-six hours out of the water when the examination was made.

During this simple series of observations of young Scaphiopi in confinement, I watched also the development of those left in the sink-hole. The water there soon was confined to mere puddles concealed in the dead leaves, and before the young had their limbs fully developed the depth was nowhere sufficient to permit of swimming. Three days in advance of the maturing of my confined specimens, I saw, in the sink-hole, a few individuals which had fairly assumed the land-living, air-breathing stage of existence. Supposing that, like those I had at home, they would burrow in the earth *where they were*, I did not visit the locality from the 21st to the 31st of July, on which date I made an exhaustive but unsuccessful search for them. Not a trace of either young or adult could I discover. It cannot be said that they were overlooked. My search was too careful and comprehensive for this, and I believe that these spade-foots, both old and young, wander farther from their breeding grounds than is supposed, or else dig far deeper into the earth than a depth of six or eight inches, as stated by Holbrook and DeKay.

I have already referred to the wonderful noises made by these animals when they congregate in pools for the purpose of spawning. At no other time do they appear to be vocal, and the question naturally arises, why, when the animal leads a life that requires no such power except for two or three days in a year, should its utterances be far louder than any or all the frogs and toads of the same locality combined? Although the animal is strictly crepuscular and not diurnal, it could readily find a mate guided by sight, and the purpose of the deafening epithalamium is somewhat hard to determine. If it could be shown that they call to each other from far distant points, the difficulty would disappear, but this they are not known to do. Apparently it is not until they are congregated in some available pool that they sing, if singing it can be called. No words yet in use in our language can fairly describe their utterances, which, it may be presumed, are expressions of delight at meeting.

A word in conclusion with reference to the peculiar spur-like process which gives the common name to this batrachian. Holbrook describes it accurately as follows: "On the internal margin of the metatarsus is a horny spade-like process, containing a bone, which moves by an imperfect joint: the breadth of this process is about a line and a half, its length one line; the cutting edge is jet black." Fig. 1 represents the left foot of an adult specimen, seen from beneath, and showing the "spade." It will also be noticed that the little toe terminates also in a horny knob, a fact which has hitherto, I believe, been overlooked.

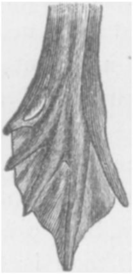


Fig. 1.—Nat. size.

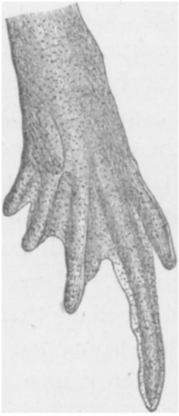


Fig. 2.—× 10.

FIG. 1.—Inside of adult left foot, natural size. FIG. 2.—Left foot of young, showing spur at earliest stage of growth.

I have already mentioned how quickly the young hoppers dug little tunnels for themselves when placed upon the earth. At that early age the growth of the "spade" had commenced, as will be seen by the drawing, Fig. 2. This is now a white, soft, cartilaginous process, differing greatly from the same feature on an adult foot. It can scarcely be of use in digging, at this time, and so leads us to infer that the young choose more yielding earth and remain nearer the surface than do the adult spade-foots. In such a case the older the creature and better developed the spade, the deeper are the subterranean homes wherein they seem to remain so closely, and from which, moved by some common impulse, they mysteriously come forth, in multitudes, to startle the passer-by with their weird cries, and then as suddenly to disappear, no one knows where.